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DESCRIPTION
OF
LEWIS DEPRESSION POSITION FINDERS

MODEL OF 1907

CLASSES AA, A, B, C, D, E, F, EE, DD, DM, AND DM1

(*FIVE PLATES*)

SEPTEMBER 1, 1909
REVISED DECEMBER 1, 1915
REVISED JANUARY 25, 1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
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WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
Washington, January 25, 1917.

This manual is published for the information and government of the Regular Army and National Guard of the United States.

By order of the Secretary of War:

WILLIAM CROZIER,
Brigadier General, Chief of Ordnance.

363170

INSTRUCTIONS

FOR

ASSEMBLING, ADJUSTING, AND OPERATING LEWIS DEPRESSION POSITION FINDERS,

MODEL OF 1907.

[The important changes in this pamphlet are shown in bold-face type.]

GENERAL DESCRIPTION.

1. These instruments are designed for measuring ranges and horizontal angles of objects from stations overlooking the sea. Ranges are automatically indicated by a pointer and dial when the telescope is depressed so that the horizontal cross wire coincides with the water line of the object. Horizontal angles are measured from *zero* degree bearing, which is generally due SOUTH from the station, and are automatically indicated by dials when the vertical cross wire of the telescope coincides with the object.

2. Ranges are measured in yards, the dials being marked for each 10 yards between the minimum (1,500 yards) and maximum (12,000 yards) ranges for classes AA, A, B, C, D, E, F, EE, and DD; for the class DM, 10 yards between the minimum (1,500 yards) and 13,000 yards, 20 yards between 13,000 yards and 15,000 yards, 25 yards between 15,000 yards and 17,500 yards, and 50 yards between 17,500 yards and 20,000 yards, **and for the class DM1, 10 yards between the minimum (2,000 yards) and 3,600 yards, 20 yards between 3,600 yards and 6,000 yards, 50 yards between 6,000 yards and 10,000 yards, 100 yards between 10,000 yards and 16,000 yards, and 200 yards between 16,000 yards and 20,000 yards.**

Horizontal angles or azimuth angles are measured to one-hundredth of a degree.

3. The principal parts are the telescope (50), the Erdman compensator and depression mechanism in the case (18), the azimuth dials (1) and (2), and the $\frac{1}{100}$ degree scale (3), the table (48), body (8), pedestal cap (33), and pedestal.

4. The telescope (50) has an achromatic objective with a clear aperture of 3 inches and focus of 25 inches, which affords well-defined flat fields of view of 3 and 2 degrees when the 15 and 25 power eyepieces, respectively, are used. The image is erected by means of Porro prisms mounted in the prism case (35).

5. The principle underlying the range-measuring feature consists in measuring the tangents of angles of depression of the telescope when directed at the water line of an object on the sea. The range dial is spiral in form and a traversing pointer indicates the range mark to be read for any position of the telescope. The graduations on the range dial are exact for one height of the instrument only, due allowance being made for curvature of the surface of the sea and normal atmospheric refraction. This height is designated the initial height and it is usually that height on the height scale (24) which locates the point of the compensating screw (11) in the slide block (42) at a distance of 7 inches from the axis about which the telescope rotates, measured horizontally along the tangent screw rail (46). When the slide block is set for this initial height the range dial gives exact range readings for all ranges, but when set for greater or less heights only the minimum and maximum ranges will be correctly indicated. All intermediate ranges will be in error to a varying extent, the errors increasing for any intermediate range as the change in height setting above or below the initial height is made greater. By means of the Erdman compensator, automatic compensation is made for these errors, which are caused by the varying effect of curvature of the surface of the sea and atmospheric refraction when the instrument is used at any other than the initial height above the sea level.

6. This instrument differs fundamentally in regard to this compensating action from former models, as well as in construction. The former models had range dials graduated for particular heights of station above sea level, with a small adjustment for variation in height, due to rise and fall of the tide only. This adjustment gave results approximately correct when the instrument was adjusted on a datum point of nearly the same range as that being measured. The present model gives uniformly accurate range measurements for all heights within its adjustment when adjusted by reference to one datum point when atmospheric refraction is normal.

When atmospheric refraction is abnormal two datum points are used, as explained in paragraph 31.

7. These instruments are made in 11 classes, designed as AA, A, B, C, D, E, F, EE, DD, DM, and DM1, and are intended for use at heights above mean low water as follows:

Height of instrument.

Class—	Feet.
AA	25 to 60
A	35 to 80
B	60 to 145
C	125 to 300
D	280 to 690
E	90 to 210
F	165 to 400
EE	300 to 750
DD	160 to 400
DM	280 to 800
DM1	**380 to 900**

By thus dividing the instruments into classes, overlapping each other so as to meet all heights, a much greater degree of accuracy is obtained than would be possible were the instruments all alike and graduated for heights of 25 to **900** feet.

8. Class AA is designed for mine fields and indicates ranges of 1,000 to 6,000 yards. Classes A, B, C, and D are designed for the batteries and indicate ranges of 1,500 to 12,000 yards. Classes E and F indicate ranges of 600 to 9,000 yards. Classes EE and DD indicate ranges of 1,000 to 6,000 yards. Class DM indicates ranges of 1,500 to 20,000 yards, **and Class DM1 from 2,000 to 20,000 yards.**

9. All instruments have interchangeable depression mechanisms (18), height scales (24), and range dials (36), making it convenient to convert an instrument from one class to another.

10. The depression mechanism is assembled as a complete unit in the case (18). The proper height scale (24), compensating cam (10), tangent screws (45), and internal gears for the class for which any particular mechanism is intended are assembled therewith in the first instance, and should not be removed.

11. When an instrument is to be converted into another class, the range dials and the depression mechanisms should be changed, the latter as units. This is accomplished by removing the table (48) from the body (8), and then removing the gear on the worm shaft, the end of which projects down through the table, the gear referred to being that which drives the range dial. When this has been done the depression mechanism can be removed as a unit by loosening four dowel screws which secure the case to the table. The proper depression mechanism should then be put in the place of the one removed and the corresponding range dial put in place of the one mounted in the table. **In assembling the depression mechanism, the gears should be meshed together when the range pointer is at the minimum-yard mark on the range dial; and also when the upper surface of the tangent screw rail is (D) inches below the axis of the telescope. The cam should at the same time be in such a position that the cam pin is at the left-hand end of the slot in the cam.** In order to remove the table from the

body it is only necessary to throw the azimuth mechanism out of mesh (see paragraph 24), remove the case containing the **pinion shaft head (7), remove the table clamp (49) (left-hand thread)**, remove the ring on the bottom of the table and loosen three clamping screws which clamp the male center in the body (see paragraph 27).

It will save considerable time in adjusting the hundredth-degree scale if the table center be replaced in the body so that the longitudinal slots are in the same relative position to the holes for the clamping screws that they occupied previously.

12. The height scale graduations serve to distinguish the class to which any depression mechanism belongs. In addition to this the following table gives the pitch of the tangent screws (45) and their nuts, and the number of teeth on the gears peculiar to each class. This table also gives a distance (D) between the top of the tangent screw rail (46) and the axis of the telescope, which is followed in assembling the depression mechanisms and in setting the compensating cams.

Class.	AA.	A.	B.	C.	D.	E.	F.	EE.	DD.	DM.	DM1.
Threads per inch of tangent screws (45) and nuts (47)	210	210	136	64	28	34	18	18	34	28	28
Number of teeth of:											
Tangent screw gears	65	75	72	72	72	72	72	72	72	72	72
Intermediate gears	47	41	41	41	41	41	41	41	41	41	41
Worm-shaft gears	25	27	30	30	30	30	30	30	30	30	30
Distance (D), inches:											
For instruments Nos. 1 to 153 inc.	**1.438**	**1.444**	**1.388**	**1.246**	**0.902**	**1.293**	**0.873**	**0.767**	**0.988**	**0.902**	**0.902**
For instruments above No. 153	**1.688**	**1.694**	**1.638**	**1.496**	**1.152**	**1.293**	**0.873**	**0.767**	**1.138**	**1.152**	**1.152**

13. In each class the range dial is graduated for that height of the instrument which requires that the point of the compensating screw (11) be set at a distance of 7 inches from the axis on which the telescope revolves. A short mark, for convenience in assembling, indicates this point on the height scale (24). The range dials (36) for each class represent the tangents of angles of depression for these initial heights, with proper allowance for curvature of the surface of the sea and normal refraction.

14. It will be noted on examination of an instrument that when the slide block (42), carrying the compensating screw (11), is at the initial height mark it is not turned by the compensating cam (10), acting through the swinging compensating bar (14), on the rack (39), since the center of the rack block (40) is directly over the pin on which the bar swings. At any other height setting, however, the rack is moved and in turn rotates the compensating screw.

15. This rotation of the compensating screw serves to correct the action of the tangent screws so as to render the indications of the range dial (36) correct for any height within the adjustment of the

instrument. The correction or compensation necessary for any range varies in direct proportion to changes in position along the height scale (24). The marks on the height scale are tangential functions of the height, whereas the changes in position just referred to are linear changes. The compensating mechanism exactly meets all the mathematical requirements of the problem and renders the range indications uniformly accurate for all heights.

16. Angles in azimuth are read by means of two dials and one stationary scale. The dial (1) concentric with the vertical axis of the instrument has marks for each 10 degrees, which are numbered from "0" to "35." On this dial are read the hundreds and tens places of degrees, the number to be read being that one which is either in coincidence with the index mark or immediately to the right of it. The planetary dial (2) has ten marks, numbered from "0" to "9," on which is read the unit place of degrees, the mark to be read being that which registers with some portion of the stationary scale (3). This scale is divided into 100 parts, numbered from "0" to "100," and on it are read the hundredths of degrees at the point where the mark on the unit degree dial registers.

ASSEMBLING.

17. *Boxing.*—These instruments are shipped in three boxes. The first contains the body and table, with four electric lamp conductors, sockets, and hoods; and three leveling screws and their sockets. The second box contains the telescope in a mahogany case, with rubber eye shield, extra spider-line cell, two eyepieces of 15 and 25 power, and four 2-candlepower, 36-volt electric lamps. The third box contains the pedestal and its cap, tools in a canvas bag, rheostat, 8 feet of twisted pair lamp cord, **and three holding-down bolts.**

18. To remove the contents of the first box, take out the screws in the cover and the screws in the sides which hold the crossbars inside the box. The contents can then be lifted out as a unit. The other boxes should be taken apart as their construction indicates.

19. Mount the pedestal on the concrete pier and bolt it to the same. Provide three small blocks of wood about 1 inch thick and place them on the pedestal cap. Place the body and table on these blocks and start the ring nut which surrounds the ball on the body into the female thread in the pedestal cap (33). Then screw the leveling screws (28) into the threaded holes in the body and down into their sockets (29), placed on the pedestal cap. Take the weight on the screws and remove the wood blocks, and as the ring nut is screwed down, lower the body by means of the leveling screws until the ball is seated in its socket in the pedestal cap. A pin wrench is provided for the ring nut.

20. Mount the telescope in the trunnion yoke (53) by loosening the clamping screws for the steel centers (54) and pulling them out far enough to admit the telescope. **The height of the axis of the telescope above the bottom of the pedestal is 52.7715 inches.** Then push the centers in so as to support the telescope and gently clamp them with the set screws. A hexagon wrench is provided for this purpose.

21. The centers should be adjusted so as to permit the telescope to move freely about its axis, but without any side play.

22. The four electric lamps should be screwed into their sockets, and the sockets and holders mounted in the lamp hoods (4), (16), (25), and (38). The current for the four lamps in multiple is regulated by means of rheostats. When the current is from 110-volt mains one rheostat is used, and from 220-volt mains two rheostats are used. The rheostat should be located on the wall or ceiling of the range-finder house, within reach of the observer. Eight feet of twisted pair lamp cord is provided for connecting the rheostat with the switch block (56) on the instrument. **A fixed resistance for 220-volt main is also supplied when requested to replace two rheostats and fuze block.**

23. In this connection, all persons concerned should be cautioned not to experiment with the azimuth or depression mechanisms of the instrument until it is fully assembled and adjusted.

ADJUSTING.

24. *Azimuth mechanism.*—To avoid injury in transportation, the instrument is shipped with the azimuth mechanism out of mesh, so that the first adjustment to be made is of the same. On a radial line through the center of the azimuth dials are four screw heads. Counting from the center of the instrument out, the first and fourth are clamping screws (6), the second is the **table-screw** (9), covering the center of the unit degree dial (2), which can be removed. The third is the shaft of the cam (5) which moves the unit degree dial into and out of mesh with a gear on the body of the instrument, inside the table. To adjust, loosen the two clamping screws very slightly, then turn the table until the index mark nearest the center of the instrument registers with any one of the hundreds and tens of degree marks. Next insert a screw-driver in the slot in the center of the unit degree dial (2) and turn it until "0" on this dial registers with "0" on the fixed scale (3). While in this position insert the screw-driver in the slot in the cam (5) and gently turn the same until the unit degree dial gear meshes with the gear in the body, and clamp in this position. When this adjustment has been made properly, the azimuth mechanism will show about one one-hundredth of a degree of blacklash, when the direction of rotation of

the table is reversed; and the table should turn nearly as easily as it did before the gears were meshed. If the resistance to turning is distinctly greater than before, the adjustment should be made again.

25. *Leveling.*—**The spirit levels (26) on the table (48) have been adjusted at the factory before shipment, but as their adjustment may be disturbed in transportation, this fact should be kept in mind in assembling the instrument. To level the instrument, set one of the levels parallel to two of the leveling screws and adjust the leveling screws until the bubbles are central. To check the adjustment of the levels, turn the table 180 degrees from its former position. If the bubbles are not central in this position, correct half of the error by means of the nuts on the screw posts (27) on which the levels are mounted, and the other half by means of the leveling screws. By repeated trials an exact adjustment can be obtained.**

26. *Orienting.*—Select some distant object whose exact bearing from the station is known in degrees and hundredths of azimuth. Turn the table by means of the **pinion shaft head** (7) until the bearing of the object is indicated on the azimuth dials. Then clamp the table to the body of the instrument and insert the large pin wrench in the hole in the side of the pedestal cap (33) and turn the cap until the vertical spider line of the telescope coincides with the distant object. As the top of the pedestal is not necessarily level, this movement of the cap will probably disturb the level of the instrument. Level again and check the bearing on the distant object. One or two trials should be sufficient to secure this adjustment, whereupon the pedestal cap (33) should be clamped to the pedestal by means of the three screws (34).

27. *Table center.*—The table (48) rotates on the body (8) on two bearing surfaces, namely, a circular track of nearly the full diameter of the body, and a shoulder bearing surrounding the male center or spindle. The male center is practically one with the body, being normally clamped to it by three screws, the ends of which bear in the bottom of longitudinal slots cut in the male center. The heads of these screws will be found in the hub of the body in the three pockets unoccupied by leveling screws. An adjusting screw runs through the axis of the male center and bears in the body. The head of this screw will be exposed by removing the telescope and its trunnion yoke (53). This screw affords a means for moving the male center up or down, so as to adjust the weight of the table between the circular track and shoulder bearings. This adjustment is carefully made at the factory, and will only be disturbed by careless handling in transportation. If it has been disturbed, it will be indicated in one of two ways; either the table will turn too freely, making it impossible to keep the table level throughout a complete rotation, or the table will not turn freely, because of undue friction on the

circular track. In the first case, correct by lowering the male center in the body; in the second case, correct by raising it. A few trials will indicate the best position, when the male center should be firmly clamped to the body and not disturbed thereafter.

28. *Telescope.*—The telescope should be mounted in its trunnions so as to move with perfect freedom, but when sprung to one side by pressure it should spring back to the same position. The trunnions and centers (54) should be thoroughly cleaned before assembling and slightly oiled. The sun shade (55) should be kept in place at all times, since it is necessary to a proper preponderance of weight over the depression mechanism. When the 15-power eyepiece is used, the counterweight (52) should be screwed out as far as possible from the axis of the telescope; when the 25-power eyepiece is used, it need not be quite as far out. For night work the spider lines are illuminated by an electric lamp in the lamp hood (16), the intensity of which can be regulated by turning the knurled **shutter sleeve** (41). If, after assembling, the telescope does not give perfect definition, take off the front of the prism case and see that the prisms have not jarred out of their seats in the prism plate, and also see that the objective cell is tightly screwed into the telescope tube.

OPERATING.

29. *Range and azimuth finding.*—The instrument is now ready for range and azimuth finding. Having ascertained the condition of the tide at the moment, set the slide block (42) along the tangent screw rail (46) to that point on the height scale (24) which corresponds with the height of the instrument. This scale is in feet, whereas the range dial is graduated in yards. Having this height setting, clamp the slide block by means of the clamping screw (44). Next bring the telescope to bear on a datum point at about 8,000 yards, then turn the **outer sleeve nut** (47), operating the depression mechanism until the range pointer (37) indicates the range of the datum point. The horizontal spider line in the telescope will, in general, be found slightly above or below the water line of the datum point. What is called an initial setting is then necessary. It consists in bringing the horizontal spider line into coincidence with the water line of the datum point, and may be accomplished by unclamping the clamp screw (12) on the compensating screw (11), screwing the latter up or down until the coincidence is established. Having found this position, clamp the compensating screw to the shaft of the rack gear which normally controls it by tightening the clamp screw (12).

30. Assuming that conditions of normal atmospheric refraction prevail, the instrument is now ready for range finding. If, however, such is not the case, it will become apparent when the range

of a nearer datum point is taken. For instance, suppose the range of such a datum point is 2,500 yards, if atmospheric refraction is more than normal (which is often the case), when this datum point is water lined, a range less than 2,500 yards will be indicated by the range pointer. If the order of making these readings is reversed, the initial setting being made on the 2,500 yards datum point, then the range of the 8,000 yards datum point as indicated by the pointer will be over 8,000 yards. If atmospheric refraction is less than normal (which is seldom the case), the reverse of the foregoing condition will be observed.

31. *Correction for abnormal refraction.*—To correct for either of these conditions, two datum points must be used concurrently, preferably at about 3,000 and 8,000 yards, and a position of the slide block, slightly different from the true height of the instrument, found, which will enable the instrument to give correct range indications for the two datum points. When this has been accomplished by repeated trials, all other ranges will be correctly indicated with but a slight approximation.

32. If the first observations indicate more than normal refraction, the position to be found for the slide block will be nearer the axis of the telescope than the true height for the instrument. If less than normal, the position will be farther away from the axis of the telescope. In any case the new position found will only be a few thousandths of an inch from the true position. This small adjustment can be readily made by using the nut block (30) as a fixed nut and moving the slide block (42) by means of the adjusting screw (43), connecting them.

CAUTIONS.

33. *The depression mechanism should not be operated until the height setting has been made.*

34. A stop has been provided to prevent an observer from running beyond the maximum or minimum marks on the range dial, and hence straining or otherwise harming the mechanism.

This stop consists of a base which is secured to the outside of the unfinished screw and gear case casting by the three holding screws, a sufficient number (16) of stop rings to permit the required travel of the range dial and a case which incloses the parts.

If the stop at any time does not allow the range pointer to travel to the maximum or to the minimum range, it may be adjusted as follows:

Turn the outer sleeve nut (47) to the limit of travel in the direction where more movement is required; hold the bottom ring to prevent dropping out of the stop rings; loosen the three holding screws in the bottom ring; then turn the outer sleeve nut (47) until the range pointer comes

to the limiting range; then tighten the three holding screws. Care should be taken that the holding screws keep the stop rings properly suspended in the case. If the outer sleeve nut (47) works stiffly, it is an indication that one of the three holding screws has been screwed in too far.

35. *The operator should be careful not to lean his head against the rubber eye shield when using the instrument.*

OILING.

36. The instrument is thoroughly oiled before final assembling and should not require oiling oftener than twice a year. The parts requiring oiling as often as this are the table center and the circular track bearing surfaces, the unit degree azimuth dial center and the compensating screw. Clock oil should be used for the table bearings and the azimuth dial center, and vaseline slightly thinned with paraffine oil for the compensating screw. The table center bearing can be gotten at for oiling in the manner explained in paragraph 27, and a few drops of oil can then be run around the top of the male center which will work down to the shoulder bearing. The circular track bearing has an oil hole in the table, diametrically opposite the azimuth window. This oil hole is closed by means of a knurled head screw. The unit-degree azimuth dial (2) can be oiled by removing the table screw (9) and running a few drops of oil around the top of the dial center. The compensating screw (11) must be removed from the slide block (42) for cleaning and oiling. This can be done by removing the slide block from the tangent screw rail (46) and removing the rack (39), whereupon the compensating screw can be unscrewed. Care should be exercised not to damage the thread, which is left hand and has a pitch of 100 threads per inch. When removed, clean both it and the female thread in the slide block with benzine and oil as above explained. All exposed steel parts should be protected from rusting at all times by a thin film of oil.

NOMENCLATURE.

1. Azimuth dial, hundreds and tens degrees.
2. Azimuth dial, unit degrees.
3. Azimuth scale, hundredths of degrees.
4. Azimuth lamp hood.
5. Azimuth adjusting cam.
6. Azimuth clamping screws.
7. Pinion shaft head.
8. Body.
9. Table screw.
10. Compensating cam.
11. Compensating screw.
12. Compensating screw set screw.
13. Compensating bar pin.
14. Compensating bar.
15. Cross-wire adjusting screws.
16. Cross-wire illuminating lamp hood.
17. Cross-wire lamp hood.
18. Screw and gear case.
19. Draw tube.
20. Eyepiece.
21. Eyepiece adapter.
22. Eye shield.
23. Adjusting wheel.
24. Height scale.
25. Lamp hood for sight scale.
26. Level.

27. Level screws and nuts.
28. Leveling screws.
29. Leveling screw sockets.
30. Nut block.
31. Nut-block clamping screw.
32. Name plate.
33. Pedestal cap.
34. Pedestal cap screws.
35. Prism case.
36. Range dial.
37. Range pointer.
38. Range dial lamp hood.
39. Rack.
40. Rack block.
41. Shutter sleeve.
42. Slide block.
43. Slide block adjusting screw.
44. Slide block clamping screw.
45. Tangent screws.
46. Tangent screw rail.
47. Outer sleeve nut.
48. Table.
49. Table clamp.
50. Telescope tube.
51. Telescope depression bar.
52. Telescope counterweight.
53. Telescope trunnion yoke.
54. Telescope trunnion yoke centers.
55. Telescope sun shade.
56. Terminal posts and switch block.
57. **Depression mechanism stop.**

The following tools are issued with each instrument:

1 chest.
1 screw driver, small.
1 screw driver, large.
1 pin wrench for bolt-socket nut and pedestal cap.
1 pin wrench for telescopic and level-screw nut.
1 wrench for turning center screw.

WAR DEPARTMENT,
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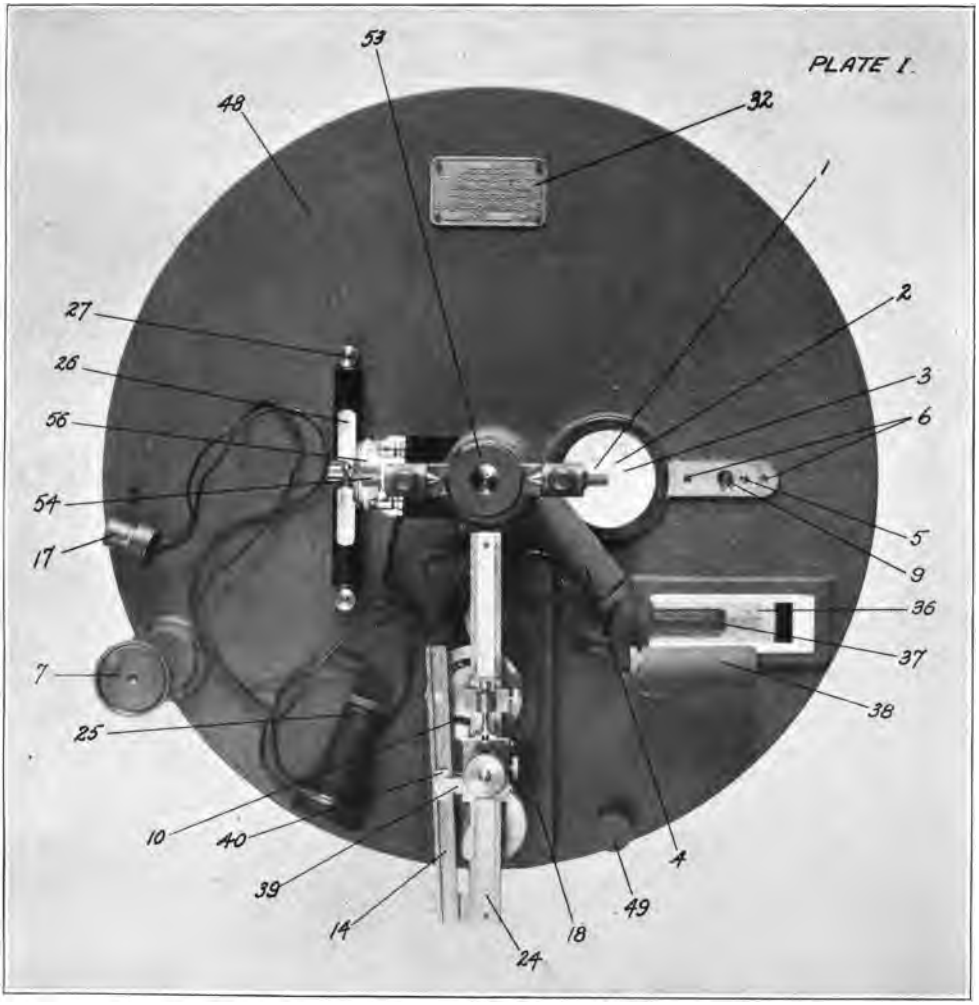

PLATE I.

YC 64393

Gaylord Bros.
Makers
Syracuse, N. Y.
PAT. JAN. 21, 1908

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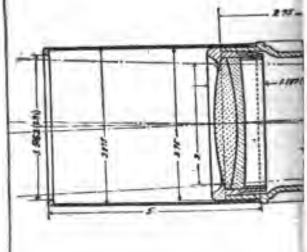

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